PTO 2008-5765

Japanese Unexamined (*Kokai*) Patent Publication No. S64-65040, published March 10, 1989; Application No. S62-220376, filed September 4, 1987; Inventor: Masahide SAITO; Assignee: Sumitomo Denki Kogyo KK [Sumitomo Electrical Engineering Co., Ltd.]

MANUFUACTURING METHOD FOR A POROUS OPTICAL FIBER MATRIX

---

2. Claim

Manufacturing method for a porous optical fiber matrix characterized in that, with a manufacturing method for a porous optical fiber matrix wherein fine glass particles generated as a result of the fact that a glass raw material and a combustion gas are fed to a burner and a flame hydrolysis reaction is caused to occur, while cooling using an ion stream generated from the corona discharge of said porous matrix, accumulation of the aforementioned glass particles is carried out.

3. Detailed Explanation of the Invention

[Field of Use in Industry]

The present invention concerns an improvement for a manufacturing method for a porous optical fiber matrix based on the VAD (vapor-phase axial deposition) method.

[Prior Art Technology]

Regarding a manufacturing method for a porous optical fiber matrix, for example, with the VAD method, $SiCl_4$ is injected in an oxyhydrogen flame, and fine SiC_2 particles are accumulated in the longitudinal direction of the departure material by a flame hydrolysis reaction. In this case, the burner that sprays the $SiCl_4$ and combustion gas is divided into a multiple-tube structure, an additive such as $GeCl_4$ or the like is

simultaneously sprayed and reacted, and GeO_2 is formed. The SiO_2, GeO_2, and the like are of a predetermined radially oriented spatial concentration distribution.

With the external method, additives such as $SiCl_4$, $GeCl_4$, and the like are fed and flame hydrolyzed; while fine particles of the formed SiO_2, GeO_2, and the like are accumulated on the outer periphery of the glass rod core, which is the departure material, the glass rod core is shifted in the axial direction of the core, and the fine particles of SiO_2, GeO_2, and the like are grown in the axial direction.

Here, $GeCl_4$ is cited as an additive to create refraction distribution, but other additives are possible, and there is a method of mixing multiple additives. Also, in the case of the flame reaction, an example wherein the reaction is caused by adding additives is shown, but a method is also known wherein a pure SiO_2 porous substance is made, and an additive is injected at the time of sintering.

[Problems the Invention is Meant to Resolve]

When a porous optical fiber matrix is synthesized at high speed by the VAD method, it is necessary to increase the raw material dosage quantity per unit of time, but because of a decrease in the adhesion performance of the glass fine particles on the porous optical fiber matrix, there has been the problem that the accumulation speed onto the porous optical fiber matrix is increased in proportion to the raw material dosage quantity.

Regarding a method to resolve the aforementioned problem, conventionally, as shown in Figure 2, method wherein cooling glass (13) is blown from a nozzle (12) outside of the burner for glass fine particle synthesis (1) has been adopted. With this method, because thermophoresis is used as a force providing adhesion to the

accumulation surface of the glass fine particles, by blowing cool gas from the nozzle, at the periphery of the glass fine particle accumulation surface, the negative temperature gradient directed toward the accumulation surface is increased, and the adhesion performance on the porous optical fiber matrix of the glass fine particles is increased.

However, when the aforementioned conventional methods are used, with the cooling used a nozzle spray current, a sudden and uneven thermal current flux is generated on the porous optical fiber matrix surface. This causes internal gas bubble residue, and cracks and the like of the porous optical fiber matrix due to the generation of heat stress, and this causes a reduction of the manufacturing yield.

The present invention was created to resolve the problems of the conventional technology, and the objective thereof is to offer a new manufacturing method for a porous optical fiber matrix wherein, at the same time that the adhesion rate of the glass fine particles onto the porous optical fiber matrix is improved, the manufacturing yield can also be improved.

[Means for Resolving Problems]

The present inventors have thought of blowing a stream of ion wind generated by corona discharge instead of conventionally blowing a cooling gas as a VAD method using the thermophoresis effect, and arrived at the present invention.

That is to say, the present invention is a manufacturing method for a porous optical fiber matrix characterized in that, with a manufacturing method for a porous optical fiber matrix wherein fine glass particles generated as a result of the fact that a glass raw material and a combustion gas are fed to a burner and a flame hydrolysis reaction is caused to occur, while cooling using an ion stream generated from the corona

discharge of said porous matrix, accumulation of the aforementioned glass particles is carried out.

Cooling using the ion wind stream characterized in the present invention as described above is explained.

Cooling by an ion wind is a method using a static cooling method, i.e., the action of a high-voltage electric field, and promoting heat transmission by increasing a thermal flux. When ions are generated by means of corona discharge from a needle-shaped electrode wherein a high voltage is applied, air molecules or inert gases inside a muffle furnace are moved by being pushed by the ions, and this becomes an air flow, i.e., an ion wind. Also, generally, when atmospheric gas is bombed by ions from a corona discharge electrode, this is referred to as an ion wind. The present invention uses this ion wind and undertakes the cooling of object. In other words, because the border layer is made thin and the thermal flux is increased, this is referred to as cooling by an ion wind. An ion wind stream has the same meaning as the aforementioned ion wind, but because the ion wind stream is uniformly extended on the object, compared to a conventional stream, uniform cooling is possible.

This is explained below with reference to the drawings.

Figure 1(a) and (b) are summary diagrams showing the manufacturing method for a porous optical fiber matrix based on the present invention and an embodiment of a device using it. In Figure 1(a), a corona discharge electrode (7), which generates an ion wind (9), is provided near a porous optical matrix (6) upwards from a burner (1); the front thereof is oriented toward the glass fine particle accumulation surface. Also, a metal net electrode (10) comprised of aluminum or nickel is provided between the porous

optical fiber matrix (6) and the corona discharge electrode (7). By implanting a negative voltage on the corona discharge electrode (7) and a positive voltage on the metal net electrode (10), a corona discharge is generated between the two electrodes. The voltage range of the present invention is 10 – 40 kV. When the ions generated by the corona discharge move from the negative electrode (7) to the positive electrode (10), the ion wind (9) is generated by bombing the gas of the atmosphere. The ion wind (9) passes the electrode (10) and arrives at the accumulation surface of the porous optical fiber matrix (6).

In this manner, because the stream generated by using the ion wind extends the accumulation surface of the porous optical fiber uniformly and to a wide extent, uniform cooling is possible, compared to the conventional method wherein cooled gas is sprayed from a nozzle and blown on the porous optical fiber accumulation surface. Therefore, the adhesion performance can be improved, without cracks and the like being generated due to inside gas bubbles and heat stress.

Figure 1(b) shows an embodiment wherein multiple corona discharge electrodes are provided. As shown in the diagram, by providing multiple electrodes (71 – 73), the cooling effect can be further increased. The metal net electrode at this time is shown in Figure 1(c). A 1-mm wire of aluminum or nickel is meshed with 5 mm × 5 mm gaps, and due to the fact that the height is approximately 2D with respect to the matrix outer diameter D and the radius R = 0.55 – 0.8D, it covers half of the outer periphery of the porous matrix.

Based on the reasons described above, by using an ion wind stream generated by the aforementioned corona discharge electrode and cooling a porous optical fiber matrix, the adhesion performance and manufacturing yield can be improved.

[Embodiment]

The actual results are explained below. Using the porous optical matrix manufacturing device comprised as shown in Figure 1(b), the burner for glass fine particle synthesis used a quadruple tube with an outer diameter of 20 mm. The gas raw material, flammable gas, and auxiliary gas were flushed with the flow rates of 0.58 l per minute of $SiCl_4$, 0.005 l per minute of $GeCl_4$, 1. l per minute of He, 6.0 l per minute of H_2, 3.0 l per minute of Ar, and 12 l pr minute of O_2. The corona discharge electrode was maintained at a distance of 2 mm from the porous optical fiber matrix.

A porous optical fiber matrix was manufactured under the aforementioned conditions, when cooling was carried out using an ion wind stream, and when cooling was done by flushing cooled gas as shown in Figure 2, and when cooling was not carried out at all. The temperature of the porous optical fiber matrix surface was 780°C when no cooling at all was carried out, 730°C when a cooling gas was used, and 733°C when cooling was done by an ion wind stream. The adhesion performance of glass particles on the porous optical fiber matrix was 63% when no cooling at all was carried out, 77% when a cooling gas was used, and 75% when cooling was done by an ion wind stream. Thus, improved results that were almost the same as when a cooling gas was used were obtained. With respect to the manufacturing yield, in the case of the use of the cooling gas, of 30 porous optical fiber matrices, defects caused by inner gas bubbles and cracks

were found in four of them, but with the method of the present invention, no defects were generated among the 30 matrices.

As has been described above, by cooling the accumulation surface of a porous optical fiber matrix by using an ion wind stream, the adhesion performance can be increased and stable manufacturing is possible.

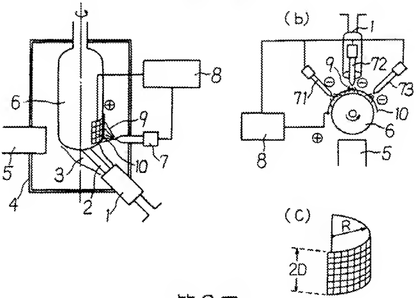
[Results of the Invention]

With the present invention, due to the fact that a porous optical fiber matrix surface is cooled by using an ion wind stream generated by a corona discharge electrode provided near the porous optical fiber matrix, cooling is carried out while maintaining a uniform thermal flux on the porous optical fiber matrix surface; therefore, inner gas bubbles and cracks generated by thermal stress non-uniformities in the porous optical fiber matrix are not generated, and the adhesion performance can be improved.

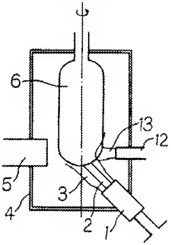
<u>4. Simple Explanation of the Drawings</u>

Figure 1(a) and (b) are summary diagrams explaining the manufacturing method for a porous optical fiber matrix based on the present invention, Figure 1(c) is an enlargement of the metal net electrode part of (b), and Figure 2 is a summary diagram explaining a conventional method.

第1図



第2図



Translations Branch
United States Patent and Trademark Office
June 20, 2008
Steven M. Spar